



Driving Out Technical Risk by Blending Architecture, Process, and Project Discipline

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14. ABSTRACT The SEI recently worked with Bursatec, the IT arm of the Mexican stock exchange, to help build an enhanced online financial trading engine. The end product had aggressive goals for performance and delivery, and it had to function flawlessly. Factors complicating a solution included scope outside the organization's recent experience, combining key technologies in new ways, and a constant stream of new requirements?challenges familiar to many in industry. To manage these challenges while instilling disciplined but nimble engineering practices, the SEI employed its Team Software Process with architecture-centric engineering to set an integrated architecture/developer team in motion. The blend of technical, process, and project-management discipline was used to systematically address technical risk. This collaborative approach offers help to organizations to set an architecture/developer team in motion using mature, disciplined engineering practices that produce quality software quickly.					
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A New Trading Platform

FINANCIAL TIMES

January 9, 2012 12:45 am

Mexico's BMV to be among fastest bourses by May

"Mr Téllez [BMV president] said that the new system's initial configuration will be able to handle 200,000 transactions per second, and take less than 100 microseconds to process a single order.

That catapults the BMV into the same league, in terms of latency, as large exchanges such as Nasdaq OMX, NYSE Euronext, Deutsche Börse and the London Stock Exchange."



Experience and Results

Architecture coaching, coupled with the discipline of the Team Software Process, built a competent architecture team and an architecture with successful evaluation quickly – less than six months.

The project objectives were met.

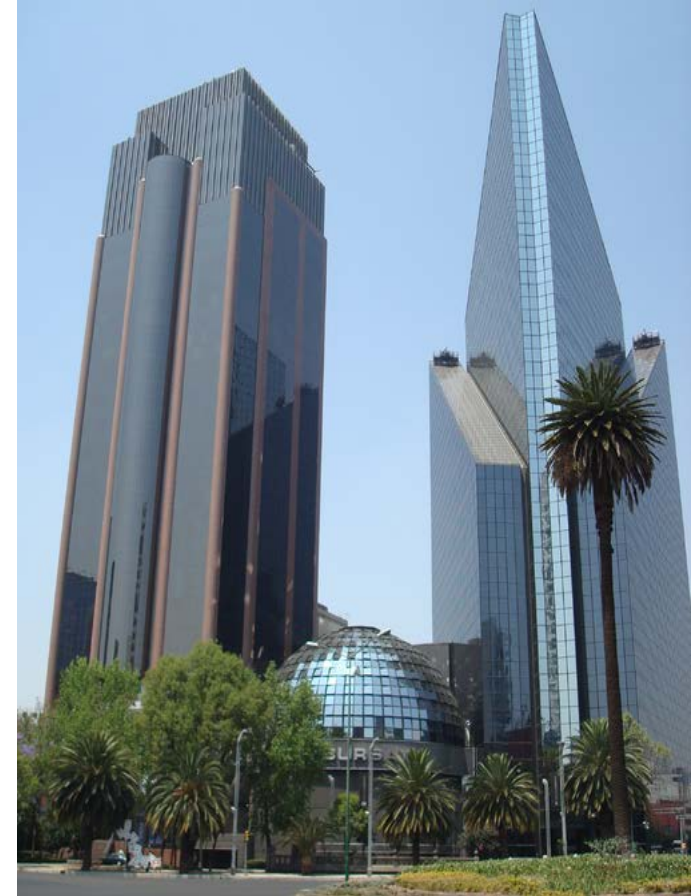
- Schedule – finished on time.
- Quality – early trials and quality metrics suggest reliability and quality goals were met.
- No known defects carried into final cycle!
- Performance – a day's worth of transactions can be processed in seconds.



The Opportunity

Background:

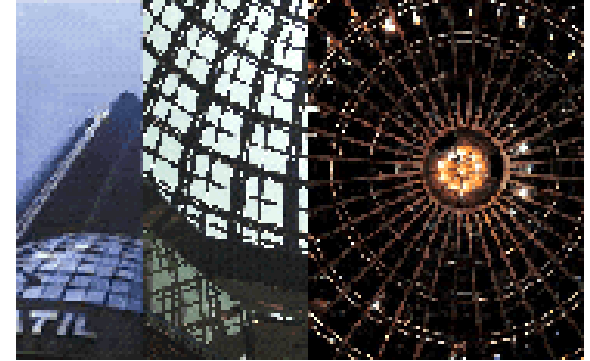
- Bolsa Mexicana de Valores (BMV) operates the Mexican financial markets.
- Bursatec is the technology arm of BMV.
- BMV desired a new trading engine to replace the existing stock market engine and integrate the options and futures markets.
- Bursatec committed to deliver a trading engine in 8-10 quarters.
- Bursatec approached the SEI for support during design and development to improve its software delivery capability.



The Project -1

Business Goals:

- High performance (as fast or faster than anything out there)
- Reliable and of high quality (the market **cannot** go down)
- Scalable (able to handle spikes and long-term growth in trading volume)



The Project -2

Architecture Decisions:

- Development in Java (lower Total Cost of Ownership)
- Low Latency Communication Multicast Network
- In memory data storage during trading session
- Hot-Hot High Availability configuration
- Parallel processing in Java Virtual Machine (JVM)
- Horizontal scalability

Functional Requirements:

- Order routing with FIX protocol interconnect to current legacy systems.
- Combined Cash and Derivatives markets with a single Control Workstation.
- Separate Market Data and Index calculation system.



Trading Engine Quality and Other Attributes

Quality Attributes

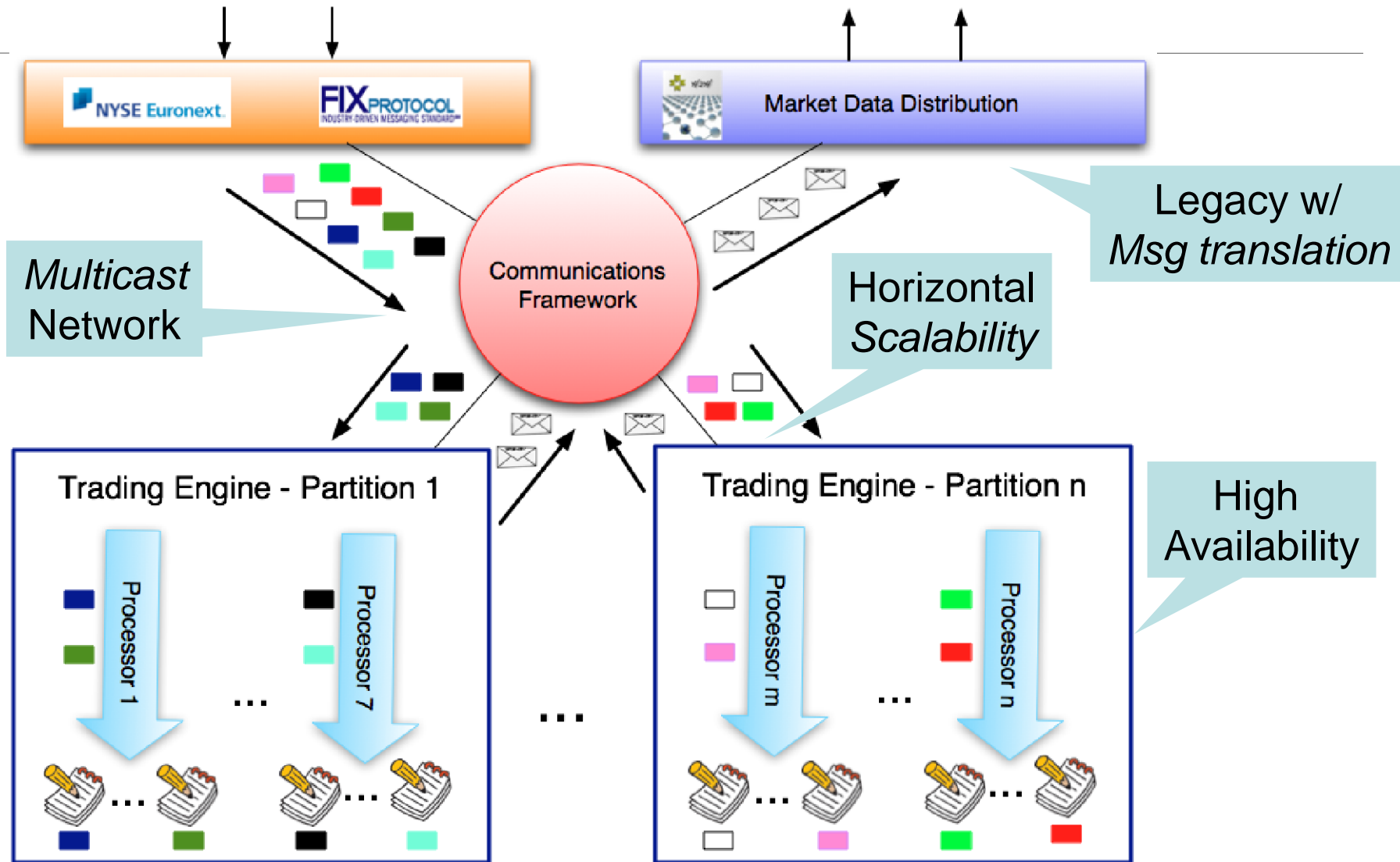
- Under 1ms processing latency
- Horizontal scalability
- Redundant high availability system
- Warm dual redundant system
- Automatic testing framework (one day turnaround attribute)
- Localize business rules changes in specific modules

Other Attributes

- Backward compatible with current systems
- Combined platform for both markets
- Run on Commodity hardware
- 86 order type/attribute combinations (30 in current system)
- Real time updates to status of system via Control Workstation.



System Context of the Trading Engine



Complicating Factors

Given the context, one would expect risks due to:

- Large project – scope beyond the organization's recent experience
 - # of person-months
 - # KLOC/function points
 - # of interconnecting platforms
 - # of individual projects
- Inexperience – available staff talented but young and key implementation technologies never used together formally
- Constant stream of new requirements and changes to business rules



Solution Integrates High-Value Architecture and Team Practices

Team Software Process

- Proven technology
- Management and measurement across the project lifecycle
- Building high-performance teams
- Key managers familiar with technology through word-of-mouth and literature.

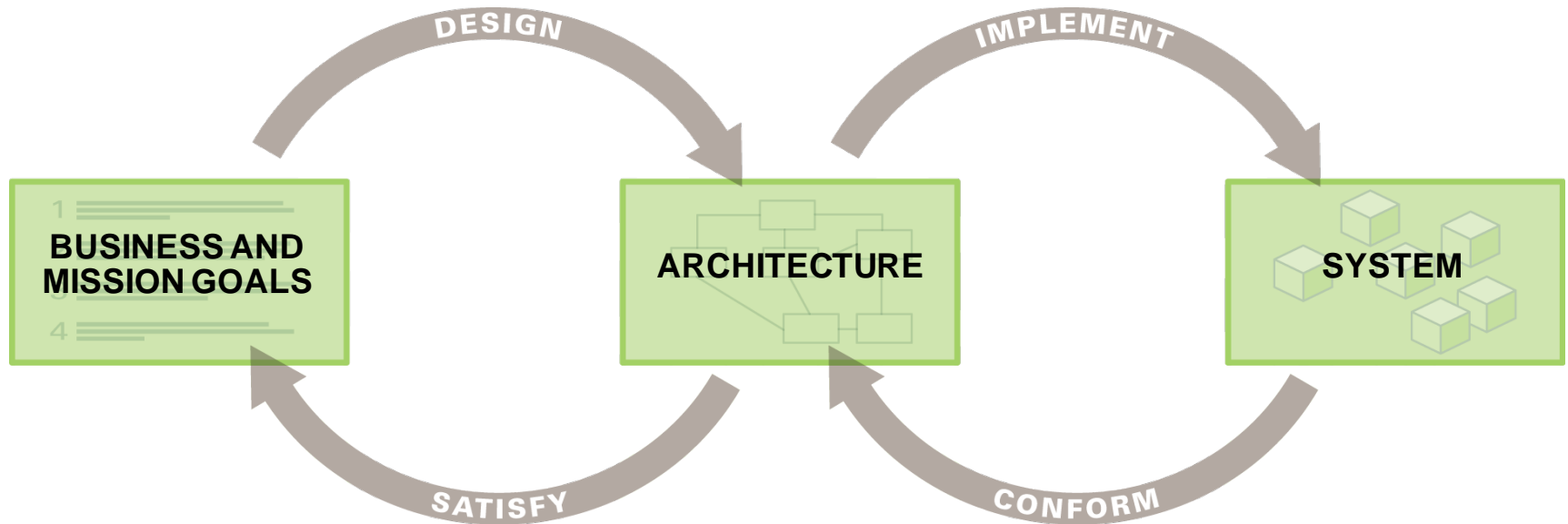
Architecture-Centric Engineering

- Proven technology
- Technical aspect of the early project lifecycle activities
- Architecting to meet business objectives
- Key managers familiar with technology via training courses.

Architecture drove the work breakdown structure (WBS) and provided a robust framework for requirements management.



Architecture Drives the Lifecycle



Two iterative processes based on the architecture of the system:

Design cycles (1, 2)

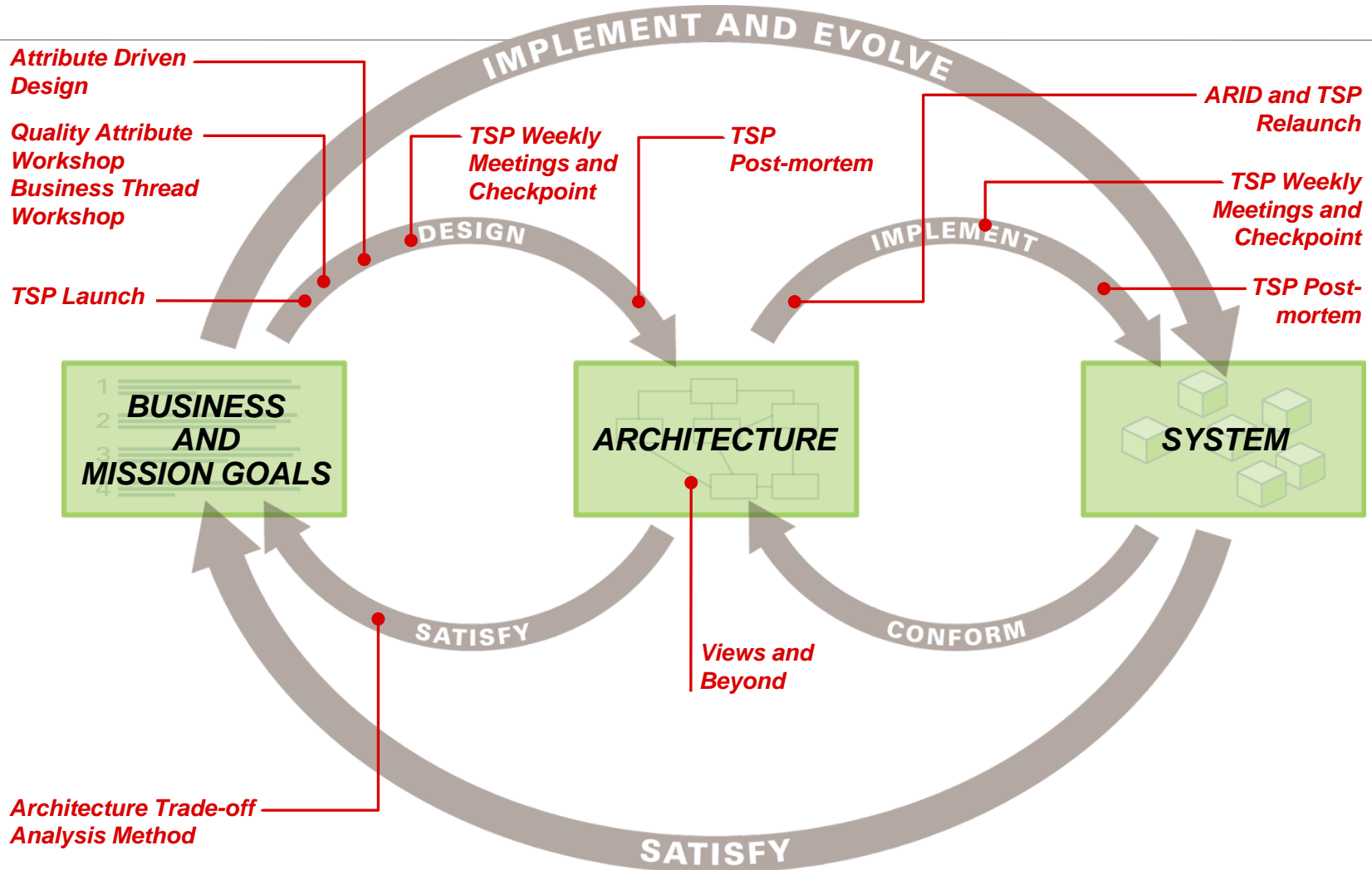
The goal is to design a system that ensures business success.

Implementation cycles (3, 5, 6)

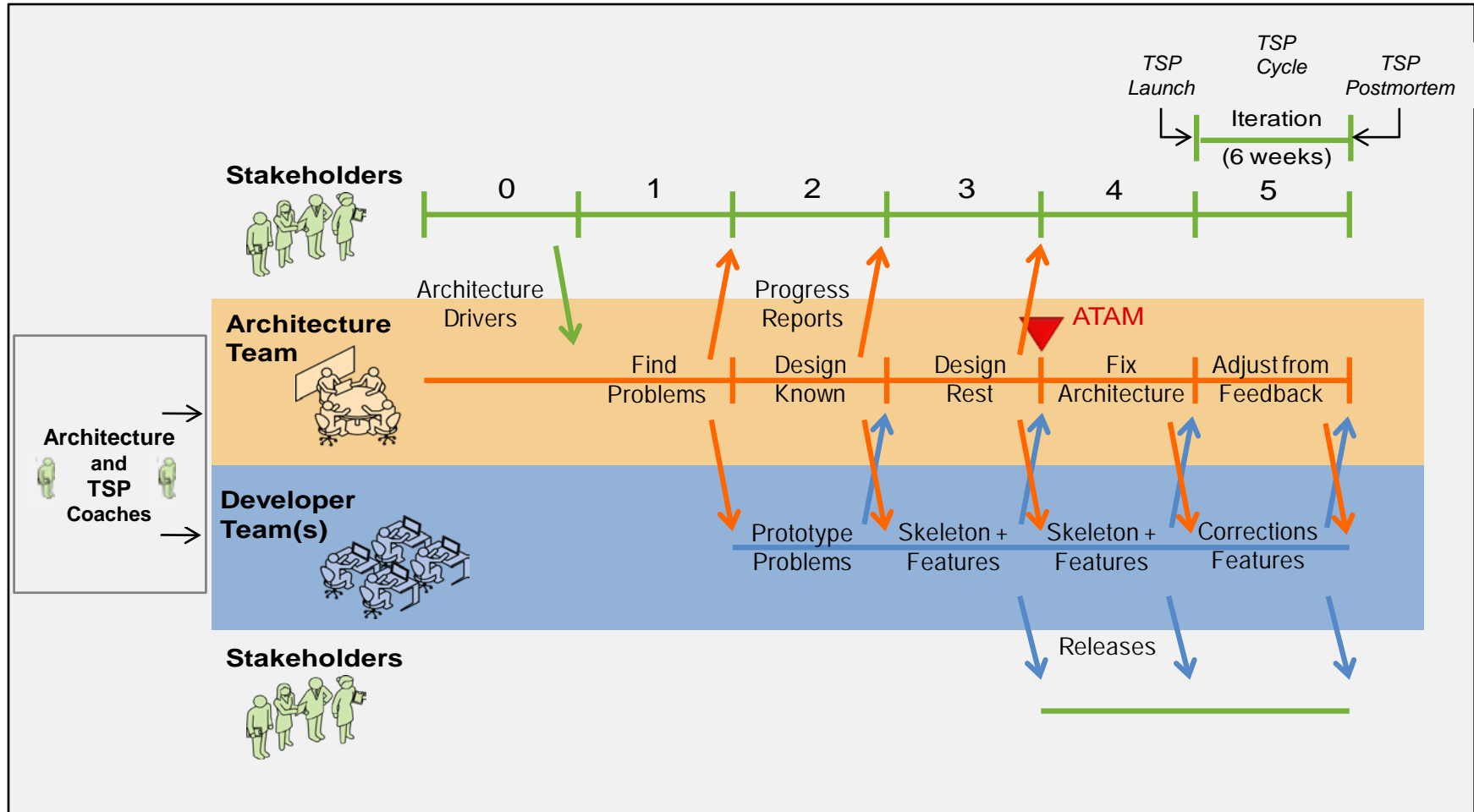
The goal is to implement the system according to the design.



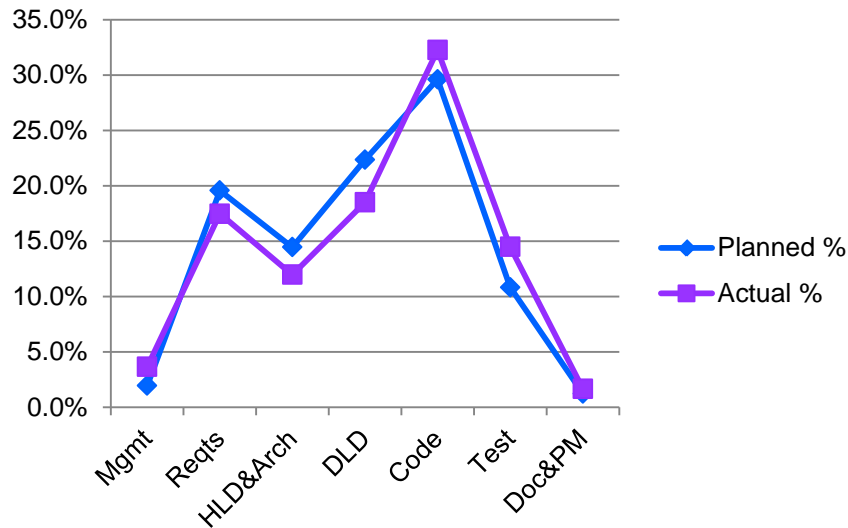
ACE / TSP Design, Analysis, and Implementation



Example Design and Implementation Strategy



Select Process Data



Effort distribution by phase blocks (% of total task hours)

- ~208 eKLOC in 24 months
- Complete functionality of previous system and new functionality
- Latency target 1msec, achieved 0.1 msec

- Architectural design practices were 12% of the total cost but were key in meeting the technical requirements and are estimated to have reduced the implementation costs by 10%-15% (due to avoided functionality and clean design)
- Only 15% effort in testing – compared to normally equal distribution between coding and testing; higher than usual quality achieved



Accomplishments

Performance

- Latency and throughput metrics greatly exceeded initial expectations (0.1 msec. vs. 1.0 msec.)

Quality

- Very low defect count in validation test. Error density 0.1 error per KLOC compared to “normal” of 0.5-1.0
- Defects encountered have not modified the architecture
- Testing framework allowed a smooth continuous integration

Cost & Schedule

- Team achieved EVERY Milestone (internal and external) on time and budget (including unplanned new functionality), with the planned number of people. No “forced march”.
-



Key Takeaways

Investment in early architecture and team practices drive the lifecycle and plays a role in managing risk.

Earlier identification and resolution of defects reduces the cost of rework.

Iterative and incremental approach fosters collaboration and facilitates handoffs reducing the cost of delay.

Architectural practices and TSP provide a disciplined framework for measuring and managing structured intellectual activity related to the product, process, and project.



Questions?



For more information: Combining Architecture-Centric Engineering with the Team Software Process, Technical Report, CMU/SEI-2010-TR-031, December 2010



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ADDITIONAL INFORMATION



Project History

Cycle 1 – Architecture

- Completed Jan. 2010, demonstrated architecture coaching, evaluation of comm. packages, built test framework

Cycle 2 – Infrastructure implementation

- Completed Apr. 2010, included successful ATAM (documentation noticeably thorough, no significant new architectural risks discovered)

Cycle 3 – Basic functions and main performance loop

- Completed July 2010, good quality, performance exceeding requirements by more than a factor of 5

Cycle 4 – Non-TSP cycle, outside evaluation by world-class experts

- Completed Aug. 2010, JVM & high-speed redundant communications

Cycle 5 – Full normal operations, complete performance loop

- Completed Jan. 2011

Cycle 6 – Full functionality incl. startup, shutdown, & maintenance modes

- Completed July 2011 (additional scope extended scheduled June finish)
-



Project History -2

Cycle 7 – System Test / Integration Test w/ Legacy Systems (starting Aug. 2011)

Cycle 8 – Acceptance Test / Parallel Test (starting Dec. 2011)

Cycle 9 – User Test / Deployment (starting Jan. 2012)

- Testing activities overlapped in part due to the Matching Engine readiness being AHEAD of other interfacing systems
- Includes internal test group, internal operations, brokerage firms testing (functional, HA, throughput ,and DRP tests)
- Operations testing detected (as of Jan. 2012) < 50 unique defects in 200+ KLOC

Go-Live Scheduled May 2012 (NOW!)



Getting Started

TSP/ACE is introduced into an organization on a project-by-project basis.

TSP Introduction Steps	
1.	Start by identifying candidate projects, architects, and internal architecture and TSP coach candidates.
2.	Train senior management.
3.	Train the selected teams and their managers, then launch the project.
4.	Monitor the projects and make adjustments as needed.
5.	Expand the scope to include additional projects and teams.
6.	Create or expand the pool of available SEI-authorized architects, instructors and coaches.
7.	Repeat starting at step 3.



Selecting Pilot Projects

Pick 3 to 5 medium-to large-sized pilot projects.

- 8 to 15 team members
- 4 to 18 month schedule
- Software-intensive new development or enhancement
- Representative of the organization's work
- Important projects

Select teams with members and managers who are willing to participate.

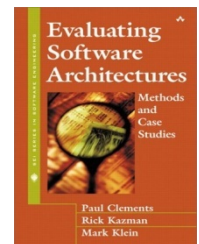
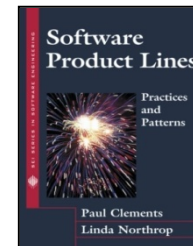
Consider the group relationships.

- Contractors
- Organizational boundaries
- Internal conflicts



Architecture Training

	Certificate Programs		Certification
	Software Architecture Professional	ATAM Evaluator	ATAM Leader
Six Courses			
Software Architecture Principles and Practices*	✓	✓	✓
Documenting Software Architectures	✓		✓
Software Architecture Design and Analysis	✓		✓
Software Product Lines	✓		
ATAM Evaluator Training		✓	✓
ATAM Leader Training			✓
ATAM Observation			✓



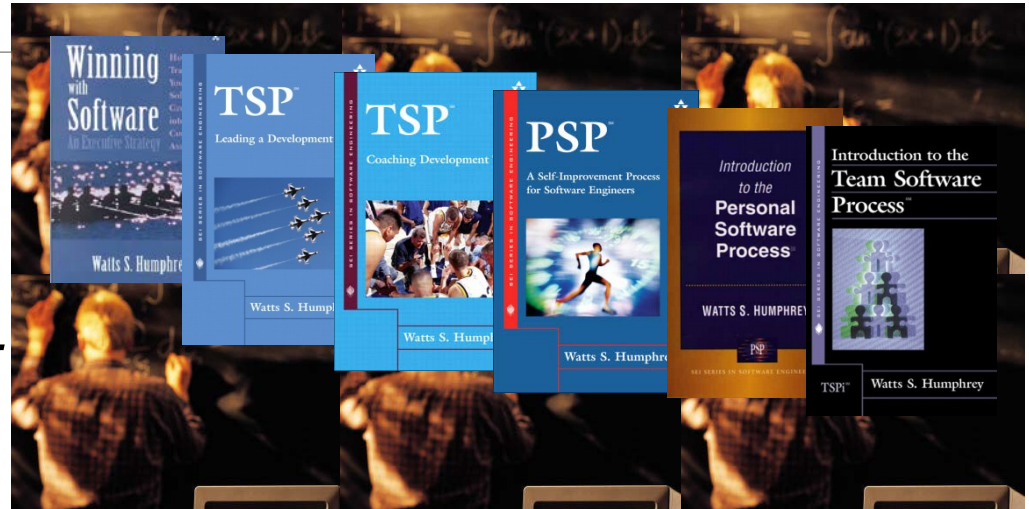
✓ : required to receive certificate / certification

*: available through e-learning



PSPSM and TSP Training

Personal Software Process (PSPSM) training is essential to successful TSP implementation.



- *TSP Executive Seminar* (1 day for top-level execs, middle managers)
- *TSP Team Leader Training* (3 days for team leads, affected managers)
- *PSP Fundamentals* (5 days for software developers)
- *TSP Team Member Training* (3 days for other disciplines)



Intellectual Property

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